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ABSTRACT

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A COMPREHENSIVE REVIEW OF THE LITERATURE ON THE EFFECTS OF BREAKFAST ON MENTAL PERFORMANCE AND SCHOLASTIC ACHIEVEMENT

by

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Abstract

A review of the literature on the effects of breakfast on mental performance and scholastic achievement reveals a dichotomy between the theoretical and the empirical literature. Whereas theoretical considerations maintain that breakfast makes a significant difference in mental performance in the late morning hours, empirical evidence can be characterized as being inconclusive. These discrepencies are mainly due to ubiquitous experimental limitations and, a proposed, inherent conflict in the imposition of scientific structures upon human experiences.

The preponderance of theoretical literature expressing the opinions of educators, nutritionists, and doctors, from the 1930's to the present, strongly suggest that there is a high correlation between the eating of breakfast and optimum mental performance. (Laird, D., Levitan, M. & Wilson, 1931; The Food Research and Action Center, 1972; Leverton, 1965; Powers, 1973; Pauk, 1983). The impact of breakfast, on the general well being and intellectual processes, is perceived as being of such significance that a homily pervades stating that breakfast is the most important meal of the day (Dickie, N.H. & Bender, A.E., 1982a; Johnson, 1968; Purnell, M. 1988; Pauk, 1983). Brooks (1988), Stokes (1968), and Craig (1986) postulate that for most people the prime time for learning is in the morning; and therefore the mind must be properly nourished in order to meet its challenges. In 1971, the Food Research and Action Center (funded by the Emergency Food and Medical Services Division of the United States Office of Economic Opportunity in 1970) reviewed the National School Breakfast Program which provides breakfast to public school children across the country. The subjective evaluations of teachers, administrators, and students on the effectiveness of the school breakfast program were striking. One California principal stated that all discipline problems in the morning ended as a result of the implementation of the breakfast program (The Food Research and Action Center,

1972). Teachers stated that students' attention spans, academic achievements, and behavior improved drastically as a result of their eating breakfast (Congressional Record, 90th Congress 1968). Students reported that they felt better, and that their concentration was enhanced when they ate breakfast in the morning (The Food Research and Action Center,1972). Other students, not involved in the review, who regularly eat breakfast realize that they must continue to do so in order not to be hungry in the morning and to be able to learn more effectively (Estronza, 1988). Robinson (1968) supports the wide-spread belief that mental performances are below optimum by mid-morning if breakfast is not eaten. Phlegar (1979) states that a child who comes to school, in the morning, hungry cannot perform as well as a child who has eaten. He goes on the say that the child who is sluggish and drowsy cannot function at optimum level. This opinion is shared by Hines, 1969; and Purnell, A., 1988. Some educators recognize that an important variable in the mathematical achievement of students is the breaking of the fast in the morning (Butts, 1988).

The literature recognizes the correlation between good nutrition, in general, and the capacity of children to develop and learn (Tseng, et.al., 1980). Pertz, D. & Putnam, L. (1982) state that research has established a direct relationship between nutrition and learning by showing that protein-poor diets produce children who are not able to learn as effectively, have lower intelligence quotients, and poorer language development.

Belisle's (1976) review of the literature suggest that there is a relationship between undernutrition, fatigue, and decreased concentration. In 1966 the National School Breakfast Act was passed upon realizing that in order to properly educate students, students must be properly nourished. (Tseng, et.al., 1980).

The National Academy of Sciences-National Research Council suggests that breakfast should contain one-fourth of the Recommended Daily Allowance. This is the amount and quality of food necessary for a healthy individual in today's society (Munro, 1985). This determination is in part established by chemical analysis of foods and body requirements. For High School boys age 14-18, breakfast should contain approximately 750 calories, 15g. protein, 35 mg. calcium, 4.5 mg. iron, 1,255 I.U. vitamin A, .38 mg. Thiamin, .38 mg. riboflavin, 5.0 mg. niacin equivalent and 13.8 mg. ascorbic acid. (The Food Research and Action Center, 1972).

Theoretical literature supports the idea that breakfast makes a major contribution to the general nutritional health of the individual, particularly growing children. Breakfast is necessary in order to meet the Recommended Daily Allowance, and to fail to eat breakfast constitutes a form of malnutrition. (The Food Research and Action Center, 1972). The importance of breakfast is highlighted when one realizes that many students do not have adequate total diets. A survey by Martin (1979) revealed that only 35% of a cross section of pupils in the Atlanta Public School system had adequate diets. The importance

of breakfast is even more acute for the poor (Francis, H. & Fleming, M., 1973). Pauk states that if breakfast is not eaten, the deficiency cannot be made up later in the day at lunch time or at dinner. It is necessary to start the day with the proper amount of nutrients. Leverton (1965) and Fleck (1971) support this opinion by explaining that the deficient body cannot make the most productive use of the nutrients received at lunch and at later meals. The body will maintain a state of relative fatigue throughout the day in an effort to recompense for earlier deficiencies (Nutter, 1988; Tseng, et.al., 1980). In a study comparing those students who ate school breakfast and lunch to those students who only ate lunch, the observation was made that the general nutritional status of the students improved for those who had both breakfast and lunch (Sulzer, J.L., Hanse, W.J., & Koenig, F., 1970). Landis (1988) states that overeating at lunch, in an effort to compensate for not eating breakfast, results in an uneven flow of nutrients to the mind and body which leads to an improper and inefficient use of the nutrients. According to Bartley and Chute (1947), overeating results in an overall blood redistribution sending a high concentration to the stomach for digestive purposes thus leaving relatively little for the brain and muscles. This results in fatigue and a decided disinclination for thought. Accordingly, since the proper functioning of the mind requires that the body be nutritionally sound, and since breakfast plays an important role in the meeting

of that requirement, breakfast is important for the proper functioning of the mind.

Blood Sugar and Mental Performance

Further theories offer an explanation for the importance of breakfast upon considering the relationship between blood sugar level and mental performance. It is generally agreed that the brain receives its energy source from the blood and from one food substance only: glucose (Wurtman, 1977). The brain has no facilities for the storage of glucose and cannot rely on the utilization of other substances if its glucose supply is reduced (Thornton, 1966; Morehouse, L.E., Miller, A.T., 1963). No other substance normally found in the blood, in vivo, can replace the utilization of glucose as a source of energy for the brain, which is dependent upon a minute to minute supply of glucose from the blood (Soskin, S., Levine, R., 1941). The brain demands a very large supply of glucose; with the body in a normal resting state, more than half of the blood sugar output is required by cerebral tissues. (Thornton,1966). It follows that when the blood sugar level becomes low, the brain functions are depressed (Morehouse, et.al., 1963; Pannell,1988; Fourest-Fontecave, 1987). Further evidence of the influence of low blood sugar on mental performance was offered by Lundgren (1946) who observed the mental changes of individuals engaged in prolonged heavy logging competitions. He concluded that resulting fatigue was not caused by muscular exhaustion but rather by the central nervous system's

requirement of a critical blood sugar level in order to maintain its normal functioning. The effects of fatigue were rapidly countered by the ingestion of glucose, as observed earlier by Christensen, et.al.(1935) under similar circumstances. Whereas Christensen observed a definite correlation between subjective symptoms of fatigue and blood sugar level, Haldi (1945) submits that a clear relationship cannot be established between fatigue and blood sugar level.

Normal blood sugar concentration is between 70-100 mg. per 100 ml. (Wurtman, 1977). When glucose concentration falls below 60-50 mg/100 ml., a state of hypoglycemia occurs, (Kamara, 1988; Taylor 1987), which is characterized by symptoms of fatigue, hunger, nervousness, and impaired mental functioning (Bartley and Chute, 1947). It should be noted that if food deprivation is allowed to advance to a state of starvation (i.e., three or more days without food, with the concomitant very low blood sugar level) the liver produces substances called ketones upon indication of the body metabolism of fatty acids (Wurtman, 1977; Fourest-Fontecave, 1987). The brain abstracts these substances from the blood as a partial substitute for glucose,thus preventing the effects of hypoglycemia (Fourest-Fontecave, 1987).

Munro (1968) refers to Van Liere's (1963) observation that hypoglycemia interferes with oxidation in the brain. She states that the frontal lobe function of the brain is particularly sensitive to a decreased supply of oxygen,and that any nutritional deficiency that interferes with oxidation would

theoretically handicap frontal lobe functions. The frontal lobes seem to be important in keeping thoughts directed toward goals, thus preventing distractibility (Guyton, 1961). Accordingly, they are also important for an increase of depth and abstraction of thought and the solving of complicated mathematical and philosophical problems.

Upon awakening in the morning after the overnight fast, it is generally accepted that blood sugar level will be relatively low: at fasting level (Tuttle, et.al., 1953). The popular theory amongst nutritionists and others states that hypoglycemia and its related symptoms will probably occur by the late morning if the proper food is not ingested (Conn, J. and Newburgh, L., 1936; Furman, et.al., 1983). It is observed that the literature advances a rather flexible utilization of the term "hypoglycemia." Mosby's Medical Dictionary defines it as a low level of blood sugar characterized by symptoms of fatigue, hunger, and impaired mental functions. Morehouse, et.al.(1963), and Thornton (1966), suggest that a rapid fall in blood level is an important factor in hypoglycemia. Kamara (1988) alludes to an index of blood sugar level concentration of below 60 mg. per 100 ml, while Taylor (1987) states a requirement of below 50 mg. per 100 ml. Thorn et al. (1943) observed the symptoms of fatigue and hunger of an individual, in the morning, and labeled them hypoglycemic. He stated the person's blood sugar level to be between 69-70 gm. per 100 ml. Is this a clear index for hypoglycemia? Haldi (1945) asked this very question. Yet, in the

very asking of the question he avoided an opportunity to make a decided rejection of the diagnosis. Conway (1947) mentions "hypoglycemic lag". Haldi designates "functional hypoglycemia". Then there is "relative hypoglycemia", not to be confused with "clinical hypoglycemia" or "spontaneous hypoglycemia" (Orent-Keiles, and Hallman, 1949). Finally, Bartley and Chute (1947) remind us that blood sugar levels are necessarily variable due to individual differences.

Content of Breakfast and Mental Performance

Another issue that arises upon investigation of the literature is the consideration of what to eat for breakfast. Protein releases glucose into the bloodstream at a rate slower than that of carbohydrates or sugars (Pauk (1983). Thus the blood sugar level remains above the fasting level, in the morning, for a longer time with the ingestion of proteins as compared with that of carbohydrates (Orent-Keils, et al., 1949). In fact, if sugar alone (i.e. candy) is eaten exclusively in the morning, the body reacts to the imbalance of ingested glucose by producing insulin which negates the effectiveness of the sugar, thus sending the blood sugar level down after a short period of time (Pauk, 1983; Coyle, Hagbery, et.al, 1983). If more sugar is eaten, the insulin can reduce the blood sugar to a level of hypoglycemia (Pauk, 1983). Since the brain, theoretically, functions best on a higher level of blood sugar, protein - which maintains a more evenly elevated blood sugar level above fasting

for a longer period of time than carbohydrates - is considered to be of particular importance in the morning (Pertz, 1982). The amount of protein recommended is usually one-four of the Daily Recommended Allowance (Arvedson et al., 1969). It should be noted that the Daily Recommended Allowance, established by scientist of the National Academy of Science, changes over the years. The determinations are made once every five years (Kamin, 1985). Although Kamin, who was responsible for determining the Allowance for 1985, stated that the amount of change in the Allowance is very small throughout the years, one-fourth of the D.R.A. for protein was 25 gm. according to the Iowa Breakfast Studies (Cereal Institute, 1962). In 1980, according to Kamin, one-fourth of the D.R.A. for protein was 15 gm. It appears that a minimum of 15 gm. is a safe determination for one-fourth of the D.R.A.

According to Smith (1979) a high carbohydrate breakfast is considered to be not as favorable as a high protein breakfast (Furmin, et.al., 1983). Whereas carbohydrates cause the blood sugar to rise relatively rapidly, the elevation does not last as long as with protein (Orent-Keils et al., 1949).

Feingold (1987) is a main proponent of the theory that asserts that over-processed sugars, refined carbohydrates (i.e. cakes), refined starches, and food additives induce hyperkinetic symptoms in children resulting in cognitive dysfunctions. Phlegar (1979) stated that sugar causes mood shifts, poor concentration and induces hypoglycemia in children, particularly

if it is eaten for breakfast. Thus Boehnlein, 1980; and Pertz, 1982 elaborate on the detrimental effects of children's diets which are high in "junk foods". This theory takes on particular significance when we consider Davidson's (1986) assessment that the food most often eaten by children is candy.

Empirical Studies

Now that it has been observed how the literature handles the relationship between breakfast and mental performance from, essentially, a theoretical point of view, it is appropriate to see what information the literature advances from an empirical point of view. Whereas theoretical pronouncements may be characterized as being aggressively definitive, with one source declaring that any attempt at educating children without breakfast may indeed be futile (The Food Research and Action Center, 1972), scientific experiments, on the other hand, may be characterized as being markedly insufficient, inadequate, and inconclusive. This dichotomy is due mainly to the inherent deceptive difficulty in performing scientific experiments and isolating causal factors when dealing with the nutritional habits of people. Dickie (1982a) analyzed the literature from the early 1930's to 1982 and discovered a total of 30 experiments dealing with the relationship between breakfast and mental and/or physical performance. The literature has been reviewed over the past 60 years, and 52 experiments have been found dealing with the relationship between breakfast and mental performance alone

: a very small number given the relative significance of the subject matter. (Dickie, et.al., 1982; Pollitt, et.al., 1978; National Academy of Science, 1973; Duke, 1986).

Upon assessing the dearth of scientific experiments, one is impressed with the incumbent limitations and methodological problems of the experimental designs. The studies that evaluate the National School Breakfast Programs, and breakfast experiments could be characterized by an absence of specific hypothesis, ambiguity of definitions and variables, a lack of data on the validity and reliability of the tests used, and a lack of consideration of limitations (Pollitt, et.al., 1978). In short the studies lack a degree of scientific rigor.

Laird, Levitan, & Wilson (1931) tested the hypothesis that hunger pangs and nervousness in children were related. Forty-eight children from grades one, three and five were studied for two weeks. Nervous children were selected by use of a behavior check list completed by the teachers. The children were divided into three groups: those receiving no special feeding (control group), those receiving milk, and those receiving milk plus a calcium supplement administered at 9:30 A.M. The teachers were not privy to the experimental groupings of the children. Subsequent analysis, by use of a behavior check list, reported a six per cent mean reduction of nervousness for those children who had the milk, and a 13% reduction for those who had the milk plus the calcium supplement. Teachers described students' behavior as being less abstracted, less slovenly in thinking, and less

mentally lethargic. It should be noted that 50 per cent of the milk fed group showed no improvement in behavior at the end of the two week period. Laird, et.al concluded that nervousness in elementary school children was related to hunger, and that mid-morning feeding of milk reduced nervousness, particularly with the inclusion of a calcium supplement. But the interpretation of the results is necessarily rather imprecise with such a limited use of statistical analysis. There were no objective tests administered. The explanation of data is made difficult by the use of the vague and idiosyncratic behavior terminologies.

Matheson (1970) investigated the effects of mid-morning supplementary nutrition by giving 110 fifth-graders, enrolled in three classrooms in three different schools, orange juice at 10:30 A.M., for a few days, within a 10 day experimental period. Students were tested on addition and reading decoding skills three times a day at 9:15, 10::30, and 11:15 A.M.. Matheson also gave a questionnaire on breakfast eating habits to the students and concluded that the eating of breakfast made no significant difference on any of the test performances. But, the orange juice nutritional supplement did. He found support for the hypothesis that supplementary nutrition and high test scores go together. His recommendation was that serious consideration should be given to the provision of a mid-morning nutritional supplement for both elementary and secondary school students. However, his determination of regular breakfast habits was obtained relatively indirectly. Several weeks after the

experiment, he acquired a three-day written food record from the students. From this he induced the usual breakfast habits of the students and projected that must have been the actual order of food consumed during the ten day test period. The breakfast consumption variable may have had a stronger impact on the test than was realized. There is also a psychological variable here. Shortly after the 10:30 supplement a test was given. The elevated test results could have been a reflection of the positive psychological experience of receiving a novel food "treat" of orange juice.

In order to determine the impact of the National School Breakfast Program on classroom grades, Kreitzman (1973) studied, for one year, third and fifth graders in two schools in Atlanta, Georgia (Pollitt, et.al., 1978). One of the two schools had a breakfast program. At the end of the year there was no difference between the two third grades in achievement test scores. But this result could have,in part, been due to the supplementary educational program that was operating in the school without breakfast. The fifth grade, in the school with breakfast, did as well or better on every segment of the achievement test than did the fifth grade in the control. But Krietzman gave a cursory description of the methods used in his study. There was no statistical treatment of data. He did not discuss apparent discrepancies in his test results.

Lininger (1963) studied, over a two year period, the effects of a school milk program on academic achievement of 4,133

undernourished children ages 6 to 16 (Pollitt, et.al., 1978). The subjective assessment of teachers concluded a 45 per cent improvement in scholastic attainment, of those students who had milk, as compared with a 25 per cent improvement for those who did not have milk. The teachers, however, presumably knew which students were receiving the milk supplements.

Lieberman, et.al. (1970) studied, for one year, 581 low income black children, half of whom participated in a school breakfast program. Tests measuring the ability to concentrate and think abstractly were administered. The authors concluded that the school breakfast program had no long-term effects on mental performance.

Fellers (1967) chose to determine whether an adequate breakfast had any significant impact on scholastic attainment. One hundred ninety eight tenth grade students, half of whom took part in the school breakfast program, were analyzed at the end of a year on their school performances. No significant difference was found in the final yearly grades between those students who had breakfast and those students who did not. But neither Lieberman nor Fellers took into consideration the percentage of students who participated in the breakfast program. In other words, students who ate school breakfast could have decided not to eat breakfast for several weeks. In fact, in the school that had the breakfast program in Lieberman's study, 52 per cent of the children participated in less than approximately 40 per cent of the breakfasts. In spite of this limitation, Lieberman

concluded that breakfast had no effect intellectually or otherwise on a school wide basis.

Pinkus (1970) compared the academic performance of fourth grade children, in eight schools in Louisiana that participated in the National Breakfast Program, with those children in school that did not (Pollitt, et.al., 1978). The school were matched for the size of the fourth grade, predominant race, and number of teachers. There was no significant difference in scholastic performance, as determined by the number of "D" and "F"s, between the two groups. But the grading by teachers does not necessarily conform to absolute and rigid criteria. It could be a relative thing. If teachers were marking on a curve, a significant difference in grades would not be expected between the two groups.

In a four year study, to determine whether impoverished children from 58 Title I Cleveland elementary schools suffered academically upon arriving to class without breakfast, Francis, H. & Fleming, K (1973) observed the school breakfast program which consisted of orange juice, cold sugared cereal, and milk; but they concluded that the objective could not be evaluated due to other projects in operation, i.e. reading improvement and math skills programs. It was noted that students improved in motivation, alertness and energy attitudes. The importance of continuing to supply breakfast to children in poverty areas was stressed.

Upon analysis, one becomes aware of the ubiquitous intervening variables that necessarily limit these experimental designs. The post and current nutritional status of the individual is a variable that may influence the impact of breakfast on the general health and ability of the individual to perform mentally. (Pollitt,1984).

Pollitt, et.al. (1983) studied the short term fasting of 20 middle class girls and 19 boys, ages 9 to 11, by feeding them dinner and,in the morning, breakfast in a clinic on one occasion. Upon returning to the clinic, seven days later, the children were fed dinner with out breakfast the subsequent morning. On each occasion, they spent the night at the clinic. The dinner consisted of 787 calories with 31 grams of protein. The breakfast consisted of 12 grams of protein with 65 grams of carbohydrates in 440 total calories. At noon, on both occasions, the children were tested on problem-solving ability, incidental learning, and short-term memory. Less errors in problem-solving were made with the ingestion of breakfast than without it. Moreover, the children in the fasting state paid more attention to irrelevant stimuli and thus used ineffective cognitive strategies. But, the cognitive problems associated with the children who fasted may not have manifested themselves in a school setting. The child may learn how to compensate effectively, in a classroom, for such cognitive limitations due to hunger. Thus the ecological validity of the study may be in question. Because there is no universally accepted definition of

hunger, communication and interpretation of results can become clouded and imprecise on occasion (Kallen, 1973).

With the analysis of the experiments of Dwyer (1973) and Matheson (mentioned earlier) opposing results are observed. Dwyer administered an instant liquid breakfast to 139 male first graders. Each child was tested individually on attention span, slow tapping test, digit test. One half of the students were fed the breakfast in the morning, the other half were fed in the late afternoon. No significant difference in morning test scores was found between the two groups. But Matheson found a significant difference in the math and reading decoding skills of those students who had orange juice, in the morning,as opposed to those students who did not. One possible explanation for the contradictory results is that the tests tapped different mental abilities. These abilities may have responded differently to the nutritional variable.

There are other intervening variables that mitigate the adequacy of the experiment thus preventing one from coming to a definite conclusion in reference to the results.

Richards (1972) studied the effect of omitting breakfast on mental performance (Dickie, et.al., 1982a). Four mental performance tests were administered, between 12:00 and 1:00, to 18 adults half of whom habitually omitted breakfast, and half of whom customarily ate a moderate breakfast. The tests were given firstly, when they followed their usual breakfast habits, and secondly when they had omitted or eaten a standardized breakfast

of 450 calories. Richards reported no change in performance that could be attributed to the omission or consumption of breakfast. However, the results indicated that for three of the four tests, performance improved when subjects followed their normal breakfast routine. Improvement in performance was less when they departed from their normal breakfast routine.

Dickie, et.al. (1982a) and Brooke (1973) assessed two methodological problems. A child who has been denied food in the morning, as part of an experiment, may internalize the deprivation and expect to perform poorly on any experiment and may proceed to do so. On the other hand when confronted with a short term test, the child may react in the opposite way and be propelled to perform with unusual ardor for the duration of the examination, thus elevating test results. This variable of motivation is well known to have powerful influence on performance (Gayne and Fleishman, 1959; Dickie, et.al., 1982a).

The number of subjects is a methodological factor in determining the validity of experimental results. Tuttle, Daum, Imig, Randall & Schumacher (1952), analyzed the effects of the omission of breakfast on choice reaction time tests which measure mental performance. For 17 weeks the total diet of the subjects was strictly regulated. The only dietary variable was breakfast. For a total of 12 weeks the subjects, men between the ages of 60 and 83, had a basic breakfast consisting of bacon, eggs, cereal and milk. One-fourth of the daily recommended allowance was met: 750 calories, 25 grams of protein, with 80 grams of

carbohydrates. The results indicated a significant difference, in the performance of the subjects, between those who ate breakfast and those who did not. But Tuttle only had eight subjects in the experiment.

There is another psychological variable that can influence results. If an individual is not sure of the quality or existence of meals later in the day, the omission of breakfast and the possible resulting hunger may be magnified psychologically and influence the disposition and performance ability of the individual. This psychological effect has been alluded to in several sources: Haldi, 1945; Thornton, 1966; Purnell, R., 1988). It is possible that, on occasion, tests that are administered may not be valid for the ability that truly wants to he measured.

A classic example of this situation is with the Iowa breakfast studies. This was research done over a ten year period beginning in 1949. The experiments were sponsored by the Cereal Institute of Chicago. The purpose of the studies was to obtain scientific knowledge in support of the idea that breakfast plays an important role in establishing human efficiency in the late morning hours (Cereal Institute, 1962). The research was done by Tuttle with a team of associates. The goal was to observe the relationship between various breakfast regimens and a range of physiological parameters (Dickie, et.al., 1982a). The experiments resulted in 25 published scientific papers. A summary of the 25 studies was published by the Institute in 1962.

One of the experiments involved a choice reaction time test. The purpose of which was to measure the reaction time, defined as the time interval elapsing between the appearance of a light switch and the response to it. (Cereal Institute, 1962). The subjects had to press a switch. The choice element was established by having a number of lights, and instructing the subjects to react only to a particular one. Tuttle, et.al. (1954, 1955) indicated that this test was being used as a measure of mental performance.

In an experiment designed to show the effects of omitting breakfast on the mental attitudes and scholastic attainments of boys twelve to fourteen years of age, Tuttle, et.al. (1954) controlled the dietary intake of 18 boys for a period of nine weeks. For a total of six weeks the boys were supplied breakfast which consisted of one-fourth of the total daily recommended allowance: 26 grams of protein, 83 grams of carbohydrates in 762 calories. The basic cereal and milk breakfast was supplied. The actual experiment lasted three weeks. Meals were planed, by increasing the dinner and lunch allowance, so that the total nutrient intake remained the same during the breakfast and "no breakfast" periods. The choice reaction time test was administered between 10:00 A.M. and 12:00 noon. It was concluded that the omission of breakfast had no influence on choice reaction time tests. There was no significant difference in the criterion between the occasions when the boys had breakfast and when they did not. But their teacher and principal, who were

participants in the experiment , observed marked differences in the intellectual performances of the students when they did eat breakfast as opposed to when they did not. Careful observations and records were made on the students' attitude and scholastic attainments. The report showed that the majority of the boys had significantly improved academic records when breakfast was eaten as opposed to when breakfast was not eaten. There were reports of students being languid and listless during periods of no breakfast. But all of these subjective observations directly contradict the scientific test results of the choice reaction time test that Tuttle was using to measure mental performance. Tuttle did not mention the discrepancy in his published scientific papers. The Iowa Breakfast Studies do not mention the discrepancy. In fact both Tuttle and the studies highlight the results, in summary, as support for the idea that breakfast improves mental performance in the late morning hours (Tuttle, et.at., 1954, 1955; Cereal Institute, 1962). Here is an example of a methodological shortcoming that was not recognized by the experimenters. Was the test valid in its attempt to measure mental performance? From a scientific perspective, how are we to accept the subjective observations of a teacher and principal who knew when the students were eating and not eating breakfast? Tuttle, et.al. tested the mental performance of other subjects, in response to the omission of breakfast by way of choice reaction time tests, on 3 other separate occasions. The experiments were similar to the one performed with the teenage

boys. The subjects were both male and female ranging in age from 21 -83. Two out of the three groups showed a significant increase in choice reaction time in response to the omission of breakfast: females age 22-27 (Tuttle, et.al., 1949), and males age 60-83 (Tuttle, et.al., 1952). There was no significant difference in the reaction time for men age 21-28 (Tuttle, et.al., 1950). In summary, of the four groups studied, two showed significant difference in test performance with the eating of breakfast, while two showed no significant difference with the ingestion of breakfast.

One possible explanation, for the discrepancy between the tested and observed results, may be that there exist a methodological weakness within the choice reaction time test itself when used as a measure of mental performance. Pollitt, et.al. (1981), in determining the effects of skipping breakfast on speed and accuracy of response in a number of problem solving, attention, and memory tasks, tested 20 middle class girls and 12 boys aged 9 to 11 years old. Participants were present at the clinic on two separate occasions. The children were served dinner on each occasion, consisting of 960 calories, 40 grams of protein with 145 grams of carbohydrates. On the first visit to the clinic, one half of the children were served breakfast consisting of 535 calories, with 15 grams of protein, and 75 grams of carbohydrates. The other half had no breakfast. On their second visit, the treatment was reversed. At 11:00 two examinations were administered. One was a Matching Familiar

Frequency Test (MFFT) which measured reaction time and accuracy in identifying matching and correct patterns from six easy and eight hard tasks. The number of errors and time to react were measured. The second was the Hagen Central Incidental Task Test (HIC) which measured a child's short-term recall and his attention to irrelevant stimuli. The authors observed that as a result of the arousal heightening stressors, caused by the morning fasting condition, subjects who did not have breakfast responded faster to the problem solving situation in the MFFT test. For the last item on the memory test (HIC), those who did not have breakfast always performed better than those who had breakfast. This, the authors stress, should not be interpreted as an effect on memory function. The effect is restricted to the last item which is probably the dominant visual stimulus. Hence, it appears that this is more an attentional than a memory effect. Thus, when Tuttle, et.al. chose the choice reaction time test to measure mental performance, those subjects who did not have breakfast may have sustained a state of arousal and reacted faster to the stimuli, compensating for the stress, producing no significant difference on the examination between those who had breakfast and those who did not.

It is interesting to note that the Iowa Breakfast Studies are considered to be the "classic" study of breakfasts (Tseng, et.al., 1980). Much of the scientific evidence, for the statements of nutritionists and others on the importance of breakfast for the improvement of mental performance in the late

morning hours, comes from this widely published Iowa Breakfast Studies. (Dickie, et.al., 1982a).

Upon considering the intellectual rigidity of the scientific method, it is possible that this orientation may be adverse to the humanistic mode of operation. There is a possible "inappropriateness" in imposing scientific conceptual dissection upon naturally occurring holistic human events, thus the probable impossibility of isolating causal factors to a particular scientific degree of specification. The ultimate truth may indeed be a subjective and metaphysical one.

But not all sources recognize the imposition of these scientific limitations. The Food Research and Action Center (1972) considered the scientific findings,in relation to breakfast, and came to the conclusion that it is being made clear that hunger in the morning severely affects the education of American school children. Tuttle came to strong conclusions about the results of his experiments and, on several occasions, did not consider the limiting discrepancies of his data.

Whereas all experiments are subject to the fore-mentioned scrutiny, several studies come to the conclusion that breakfast has a decided impact on mental performance in the late morning hours, while other studies come to the conclusion that breakfast has no impact on mental performance in the late morning hours.

Martin (1979), Moresco (1982), and Brumfield (1985) achieved results that indicate the importance of breakfast for academic achievement. Martin surveyed the breakfast habits of 834 fourth

grade pupils, in 20 schools in Atlanta, to determine the relationship between breakfast and scholastic performance. A three day diet record was obtained from the students and analyzed. One of her conclusions was that breakfast makes a vital contribution to the total diet adequacy and to scholastic achievement.

Moresco (1982) attempted to ascertain whether significant decline in memory functioning would occur in a state of fasting, as compared to a non-fasting state. First and second graders were divided into two groups, and on two consecutive days, each group served as the experimental and the control group. The experimental group received a nutritionally balanced breakfast. The control group did not. The memory test consisted of the students listening to the presentation of six digits and then writing them down. A highly significant decline in memory function occurred in the fasting state.

Brumfield (1985) set out to determine as to whether fourth grade children who participated in a school-sponsored breakfast program, for four years, would have higher achievement test scores, on the California Achievement Test in Reading, than those children who did not participate in the program. The results showed significantly higher test scores for those children who participated in the school breakfast program. These results agree with those of Chambless (1978).

But Duncan, 1982; Norstrand, 1971; Lewis, 1982; and Dickie, et.al., 1982b observed that breakfast made no significant impact

on mental performance. Duncan, in her doctoral study of 80 second grade students, found no significant difference in reading achievement test scores between those students who had experienced a breakfast program and those students who did not.

Norstrand (1971) divided ninety-two pupils, in eleven poverty area elementary schools, into four groups depending upon the length of involvement in a federally funded school breakfast program. He found no significant difference in the Stanford Reading Test scores in favor of the group with the greatest participation in the breakfast program.

In order to examine the effects of skipping breakfast on children's short and long term memory, mental tempo, and problem solving accuracy, Lewis (1982) admitted 39 nine-to-eleven year old children for overnight stays at a clinical research setting for two nights, approximately one week apart. The children were given the Hagen Central Incidental Recall Test, the Matching Familiar Figures Test, and the McCarthy Digit Span and Tapping Tests. The subjects experienced the skipping of breakfast and an 18 hour fast. Analysis of results indicated that the skipping of breakfast did not significantly effect most test performances. Although, with the problem-solving accuracy test, those who had breakfast performed significantly bettter than those who did not. But, with the incidental recall test, those subjects who did not have breakfast performed significantly better than those subjects who did who did have breakfast.

Dickie, et.al. (1982b) performed two experiments on the effects of the omission of breakfast on mental performance. The first experiment compared the performance of 260 fourth grade pupils who habitually ate breakfast with those who did not. The assessment of mental performance was a simple cancellation test, where subjects were instructed to cancel matching letters on a page. This stood as a measure of visual acuity, attentiveness, and vigilance. The tests took three minutes. Scoring was based on both speed and accuracy. The students were tested before lunch and after, thus serving as their own controls. The rationale behind this was that if the lack of breakfast reduced performance, then it would be expected that after lunch (approximately 4:00) the student would have regained all composure suffered from the lack of food in the morning. The students performed the experiments twice, on two days, one week apart. A short questionnaire, completed before each test, determined the breakfast consumption for each pupil that day. Breakfast was defined as any food eaten in the morning before the arrival to school. The results showed no significant difference between the habitual breakfast eaters and those who did not eat breakfast.

The second experiment consisted of 50 students, age 17, who were divided into two groups. All subjects habitually ate a substantial breakfast daily. On three consecutive days, the experimental group would not have breakfast. Its score on the test would be compared with that of the other group which had its

regular breakfast meal. The tests used were a simple addition test and a simple matching of letters test. The students were tested at 11:30 A.M. The results indicated no significant difference for the two groups. The omission of breakfast had no significant deleterious effect on mental performance.

Koonce (1972), and Sulzer,J.L.,Hanse,W.J., & Koenig (1973) studied the physiological performance of those elementary school children who received both breakfast and lunch, as opposed to those who received only lunch (Pollitt, et.al., 1978). In Koonce's study teachers rated students, for three months, on general disposition. Students who received both breakfast and lunch scored significantly higher, on all areas assessed, than those students who received only lunch.

Sutzer, et.al. studied malnourished children for a six months period. The breakfast served consisted of milk or fruit, roll, cereal or an egg, and occasionally meat. Children who had both breakfast and lunch performed significantly better than children who had only lunch on tests measuring verbal intelligence, attentiveness, motor speed, sorting, selecting, differentiation and conceptual ability, seeing of relationships, and making associations. The only test where there was no significant difference between the two groups was with the reaction time test. Similar results were obtained by Smith, J. (1973).

But these results conflict with those of Bender (1982) and Lindeman (1986). Bender studied the breakfast eating habits of

thirty first-graders, and thirty third-graders, half of whom were of low socioeconomic backgrounds, and half of whom were of high socioeconomic background. A Comprehensive Test of Basic Skills was administered. The conclusion was that the overall regularity of breakfast eating patterns was unrelated to student achievement.

Lindeman (1986) studied one hundred eighty-four third and fourth grade students to determine the effect of breakfast and no-breakfast conditions on children's late-morning social and emotional behavior. Teachers observed and rated the students using the Conners Teacher Rating Scale. The children also completed a food survey questionnaire. Morning behavior did not differ significantly between those students who ate breakfast,and those who did not. While children who ate breakfast tended to score lower on ratings of conduct problems, hyperactivity, inattentiveness/passivity, and hyperkinesis, these results were not statistically significant.

Four authors studied the effect of a snack on mental performance, which resulted in four different observations. Dwyer, et.al. (1972) studied the effect of a snack of 300 calories on school performance (Dickie, et.al., 1982a). Seventy-five children received the snack in the early morning before testing. Another 75 received it in the afternoon after testing. Scores, on the three tests of selective attention (digit, slow tap, and blocks), improved for those students who had the A.M. snack. But the authors were not sure whether to attribute the

results to nutritional intervention, positive psychological effects of feeding, or some other cause.

Furman, et.al., (1983) used the California Test of Basic Skills for Mathematics to test the achievement of 200 second through fifth grade children who had a midmorning snack of nuts and raisins, for approximately six months, and those children who did not have the snack. The experimental group showed growth in mathematics, but the results were not statistically significant.

Duke (1986) studied the impact, on mathematical achievement, of a midmorning snack of almonds and raisins on students in grades two through six. The study found that the snack made no significant difference on the mathematical achievement of the students. She recommended that school districts weigh the cost of the nutritional intervention program, with the probability that it will benefit some students.

But Matheson (1970) (mentioned earlier) found positive results between a mid-morning snack of orange juice and performance on school type tasks, and recommended that serious consideration be given to the provision of mid-morning nutrition to both elementary and secondary school children. The discrepancy in these results may be somewhat "allayed" by Martin's (1979) student survey which concluded that of nine nutrients, the ones with the highest correlation to academic achievement were vitamin C, and calories. Also, Landis (1988) mentioned that vitamin C is the nutrient lacking in most adolescent girls. It is also possible that the fructose from fruit sends energy to the

bloodstream, rapidly, thus relieving a possible low blood sugar level that would result from insufficient amount of proper food in the morning. The fructose would maintain a more evenly elevated blood sugar level than that of simple glucose (Hargreaves ,1984).

But it must be added that the ingestion of fruit juice has not been met with a universal response. Tavano (1971) sought to determine the effect of a liquid mid-morning snack on the performance of students on an academic achievement test, administered in the late morning. Two hundred eighty-six fourth grade students, enrolled in the Lansing Michigan School District, were randomly divided into two groups. One group was given a "placebo", while the other was given a liquid snack of pineapple juice at mid-morning. An achievement test was administered that morning. Results indicated that there was no significant difference in test scores between those who had the snack and those who had the placebo.

Blood Sugar Level and Mental Performance

Since the theoretical literature makes an association between not eating breakfast and low blood sugar, it is appropriate to look at those breakfast experiments that took into consideration the blood sugar levels of their subjects. Six such experiments have been found. Four authors found a positive relationship between blood sugar level, breakfast, and mental performance. Two found no significant relationship between blood

sugar level, breakfast, and mental performance.

Powers (1973) studied the relationship between blood sugar level and learning. He concluded that optimum learning occurred when the blood sugar level of an individual approached the ideal glucose tolerance curve, established by Tintera (1955). His experiments involved 260 children and young adults with wide ranges of learning difficulties. His treatment for these learning problems was a dietary one. Carbohydrate consumption was limited to 150 calories a day. Breakfast was a necessity, and had to contain high concentrations of protein. As a result of this diet, blood glucose curves of his subjects approached the ideal curve. Children's low reading levels began to increase. Visual difficulties were eliminated. Teachers reported improved behavior and learning abilities. It should be noted that these academic results are subjective reports from teachers and subjects.

In Pollitt's experiment (1981), children who did not eat breakfast, and had a lower blood sugar level, had significantly lower scores on the Matching Familiar Figure Test, on the whole, than those students who did eat breakfast.

Whereas Boudreau (1983) was not studying breakfast per se, she was analyzing a condition that is similar to the fasting state and low blood sugar level that can occur by mid-morning without breakfast. In the investigation of the relationship between reading comprehension and low blood sugar, six, seven to twelve year olds, with reading difficulties, were given a blood

test and a reading comprehension test. The results of the test indicated that a relationship did exist between low reading performance and low blood sugar level. When the subjects were given a snack, their reading performance improved. She stated that the results supported the theory that children who experience low blood sugar can have reading difficulties.

Fourest-Fontecave (1987) studied the influence of hypoglycemia, after an overnight fast, on the mental functions of eight healthy males ages 25 -34. Hypoglycemia was induced by an insulin-glucose clamp technique. Mental alertness was assessed by measuring the recognition time, moving time, and total reaction time to a visual signal, and by a verbal mental test, and a synonym learning test. Compared with normal conditions, hypoglycemia, after an overnight fast, prolonged the time for both the reaction test and the mental test. The learning effect of the synonym test was reduced.

But whereas these authors found that blood sugar level had a significant influence on mental performance, Arvedson, et.al. (1969) and Cooper & Brooks (1979) found that blood sugar level did not have a significant effect on mental performance. Cooper & Brooks tested four male subjects for one hour at 7:00 P.M. Each subject took the simple and complex reaction tests (a measure of mental performance) four times under four different dietary condition: (A) a normal feeding throughout the day (B) a nine hour fast following a standard breakfast (C)&(D) a high energy glucose drink,and a low energy drink administered at 7:00

after a nine-hour fast and a standard breakfast. Pre and post blood glucose tests were given. The results showed no significant difference in the simple and choice reaction tests under the varied blood sugar levels.

Averdson, et.al., (1969) studied 40 boarding school boys, ages 11-17, by exposing them to two types of breakfast diets. One high in protein and high in carbohydrates, the other low in protein and high in carbohydrates. One high protein diet contained 41 grams of protein with 46 grams of carbohydrates. One low protein diet contained 8 grams of protein with 80 grams of carbohydrates. Caloric content of the breakfasts was equated at an average of 450 calories. The mental tests, given twice a week for four weeks, measured attentiveness, memory, concentration, persistence, and continuous and strenuous mental arithmetic.The results indicated that the blood sugar level, three hours after breakfast, was highest for the high protein diet: mean value of 88m/l; next came the" no breakfast" blood sugar level: 84m/l; and the lowest was the high carbohydrate, low protein diet blood sugar level: 79m/l. But there was no significant difference on the mental tests amongst the three blood sugar readings. The high blood sugar concentration of the protein diet was not associated with a feeling of well being. Children were least tired with the carbohydrate diet which, the author noted, was closest to their own diet. On the other hand, these results conflict with the theory that high blood sugar level, and increased protein content in breakfast diets, are associated with

greater mental efficiency and feeling of well being. These results also conflict with the theory that a high carbohydrate diet causes mental fatigue due to the subsequent rapid fall in blood sugar level.

It should be noted that Galloway & Robertson (1949) observed that blood sugar levels for children who ate "poor" breakfasts or no breakfast at all were within normal ranges by late morning. While Bryant, et.al (1954) found that 10 grams of protein in 600 calories was not sufficient to maintain the blood sugar level above fasting after three and one half hours for men aged 20-30 years. Galloway & Robertson's findings conflict with theoretical literature that assumes low or hypoglycemic blood sugar levels for those who do not eat breakfast. But Orient-Kiels (1949) gave support to the theory with experiments that indicated that a minimum of 22 grams of protein was necessary in order to keep blood sugar levels from falling below fasting level by late morning. Haldi's (1949) experimental results indicated that a breakfast high in carbohydrates did not result in a rapid fall in blood sugar level by mid-morning; whereas,Thorn's experiment indicated that a rapid fall in blood sugar level was the result of a high concentration of carbohydrates.

Breakfast Content and Mental Performance

The issue as to what to eat for breakfast and how it relates to mental performance is to be considered. Seven studies were found that directly considered this issue. Of the seven,

three concluded that protein makes a significant difference in mental test performance in the late morning hours. While, four concluded that protein makes no significant difference in mental test performance in the late morning hours. Arvedson, et.al., (1969), Morrell (1977), Tavano (1971), and Purnell (1989) found no significant difference in scores with the ingestion of protein. Powell (1973), Hanes (1983), and Stein (1984) found significant to moderate improvement in test scores with protein ingestion.

Averdson, et.al., found that neither a breakfast high in protein content nor one high in carbohydrates made any significant difference on tests measuring mental performance.

Tavano (1971) defined an adequate breakfast as one containing a minimum of ten grams of protein, and proceeded to test 286 fourth grade students on academic achievement in the late morning hours. There was no significant difference between those subjects who ate an adequate breakfast and those who did not.

Purnell, J. (1989) tested thirty eight students, 17 boys and 21 girls, who attended a New York City public high school consisting mainly of a lower and lower middle income population. The children completed a questioinnaire and participated in a five months study that compared performance, on the New York State Regents Compentcy Test in Mathematics, between those students who habitually ate a nutritious breakfast, consisting of a minimum of seven grams of protein in 170 calories, three or

more times a school week, and those students who habitually ate a non-nutritious breakfast, consisting of "junk food", three or more times a school week. The results showed no significant difference in mathematics test performance between the two groups.

Morrell (1977), testing the theory that minimal levels of protein are necessary, performed an experiment with 52 children in a Santa Barbara, California elementary school. One half of the students received the standard federally funded breakfast which was high in carbohydrates and low in protein. The mean protein content for the breakfasts was 11 grams. A sugared item usually came with the breakfasts. Morrell described the breakfast as the type that is usually considered to predispose children to hypoglycemic symptoms. The other half of the students received a breakfast high in protein and low in carbohydrates, consisting of such items as hamburger and foods normally associated with lunch or dinner, with a mean of 24 grams of protein. During the 20 day experimental period, students were observed, just before lunch, on three main types of performances: On Task Behavior, where their attention and concentration was monitored; Digit Span Forward Test of the Weschsler Intelligence Scale; termination responses, where their desire to end an activity was recorded. Morrell found no significant difference in the performance of the two dietary groups on the tasks observed. He concluded that the federally funded type A breakfasts, consisting of juice, cereal, milk, and a protein item four times a week, was of sufficient

nutritional value to maintain late morning activity. He found insufficient evidence to warrant the increase expense to taxpayers required by adherence to a regulated high protein, low carbohydrate diet.

Whereas Morrell found that a relatively high protein, low carbohydrate breakfast offered no advantage, mentally, over a relatively low protein, high carbohydrate diet, Powell (1973) found that a diet and breakfast high in protein and low in carbohydrates offered dramatic improvement scholastically, particularly for those with academic deficiencies.

Hanes (1983), through statistical analysis of children's behavior, ages five through ten, concluded that breakfasts high in protein and low in carbohydrates offered consistently positive, although very small, behavior results thus increasing attentiveness.

Stein (1984) studying the effects of improved breakfast nutrition on academic achievement, gave 142 intermediate school children the Gates MacGinitie Reading Test after dividing them into two groups: one receiving a different breakfast menu each day providing a high density of both carbohydrates and protein, and the other group receiving a standard breakfast of fruit, milk, and package cereal. A trend was observed that indicated that the experimental breakfast may be associated with greater gains in reading scores.

Breakfast and Mathematics Performance

Ten experiments study the relationship between breakfast and a test of mathematics ability. Matheson (1970) gave mid-morning orange juice supplements to 110 fifth graders and found a significant difference on tests of addition between those who had the snack and those who did not. Furman, et.al., (1983) gave a math achievement test to 200 second through fifth graders at mid-morning and found a slight, but not statistically significant, growth in mathematics for those who had a snack of nuts and raisins. Meyers, A., et.al., (1988) studied elementary school children for one year and found a small statistically significant increase in math test performance for those who participated in the school breakfast program as opposed to those who did not.

Simeon, D. & Grantham-McGregor, S. (1989) compared severly malnourished and undernourished children with a control group of properly nourished children and found that the sub-nourished groups were adversely affected in their performance of a number of cognitive functions, including arithmetic, by the omission of breakfast. Although, the properly nourished control group was not adversely affected by the omission of breakfast in the performance of any of the cognitive functions. In fact, in the control group, those children who did not eat breakfast received higher scores in arithmetic than those children who did eat breakfast.

Powell, C., Grantham-Mcgregor, S. & Elston, M. (1983) studied, for three months, undernourished Jamaican children by comparing mathematics, spelling, and reading test performances

between those children who had a "Jamaican school meal" breakfast of milk, banana cake, and minced meat and vegetable patty, and those children, in the control group, who had tea with syrup. Math scores improved significantly for those who had the breakfast. There was no significant difference in spelling or reading test scores between those who had the breakfast and those who did not.

Further studies of Matheson, Dickie, et.al., (1982b), Duke (1986), Averdson, et.at. (1969), and Purnell, J. (1989) indicate that breakfast made no significant difference on math examination scores. Matheson gave a food survey to students and subsequently determined the insignificance of breakfast on math test scores. Dickie, in a three day experiment, concluded that habitual breakfast eaters did not suffer, mathematically, from an abstinence of breakfast. Duke found no significant difference on math achievement test results with the ingestion of a morning snack of nuts and raisins; and Averdson, et.al., found no significant difference on continuous and strenuous mental arithmetic results, for blood sugar levels that ranged from an average of 79 ml/ per cent to 88 ml/ per cent, nor for breakfast protein content that ranged from 8 grams to 40 grams. Purnell, J. (1989) found no significant difference in mathematics test performance between those students who habitually ate a breakfast of protein, and those who habitually ate a non-protein "junk food" breakfast.

Conclusions

Upon considering the overall conclusions one can come to in analysis of the breakfast experiments as a whole, there are five major sources that have addressed this issue: Dickie, et.al., 1982a; National Academy of Science, 1973; Tseng, 1980; Pollitt, 1978; and Nelson, 1981. Dickie observes that the early studies were based on subjective assessments. He states that the Iowa Breakfast Studies produced few clear cut results, and that subsequent experiments have not indicated that the omission of breakfast is detrimental in terms of measured performance. The National Academy of Science, upon considering the National School Breakfast Program, concluded that the influence of breakfast programs on improving school performance has not been documented. They state that careful studies on the physiological effect of hunger are needed. Tseng concluded that the literature suggests that breakfast plays an important role in the mental health of children but that more extensive research needs to be done. She sees the statements by students and educators, published by the Food Research and Action Center, to be well documented sources attesting to the effectiveness of the breakfast program. Pollitt criticizes the evaluations of the National School Breakfast Program as not being serious scientific investigations. He states that no conclusions can be drawn from these projects. In reference to the short term and the individual breakfast studies, he concludes that the experiments suggest that breakfast may benefit the student emotionally and enhance his/her capacity to

work on school-type tasks. Upon considering the studies of the school nutrition programs, Nelson (1981) concluded that the short term studies yielded conflicting results, while the long term studies failed to conclusively demonstrate significant relationships.

Of the 52 studies uncovered, 28 suggest that breakfast has a positive impact on mental performance, and 24 suggest that the eating of breakfast makes no significant difference in intellectual performance. Deciding the reality of the situation cannot be reduced to simple numerical balancing. The omnipresent methodological shortcomings, the recurring intervening variables and limitations, the dichotomy between scientific proof and natural human realities leads the author to conclude that scientific proof is unattainable. This does not mean that experiments should not be done, for every study , regardless of the outcome, brings one closer to an understanding of the problem and the human experience.

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